Comparative Study of Safety Related Core Parameters for a LEU and Mixed Fuel Core of a Swimming Pool Type Research Reactor

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Pakistan Research Reactor PARR-1 is a swimming pool type research reactor utilizing, Low Enriched Uranium (LEU) fuel and operating safely at thermal power of 10 MW. It has been planned to operate the reactor with the mixed LEU and HEU (Highly Enriched Uranium) fuels. To evaluate the performance of the mixed fuel core in comparison with the presently operating LEU core from safety point of view, calculations have been performed for safety parameters of both the cores. The calculated parameters include average power density in the fuel region, power peaking factors, power density profile in the hottest channel and reactivity feed back coefficients related with variation in fuel temperature, moderator temperature and moderator density. Cross sections generation lattice cell code WIMS-D/4 and core analysis code CITATION have been employed for this purpose. For these calculations, burnup dependent cross sections data has been generated for LEU and HEU fuels at normal operating core conditions as well as at various fuel and moderator temperatures, and moderator densities.

The comparison of calculated results for PARR-1 mixed fuel core with that operating LEU core reveals that; i) the average power density in fuel region for mixed core is slightly higher, ii) the total power peaking factor for mixed fuel core is about 5% less , iii) average value of fuel temperature coefficients for mixed core is about 15% smaller iv) no significant difference is found in the values of moderator temperature coefficients for both the cores, and v) moderator density coefficients for mixed core are less by about 6%. Though lower values of fuel temperature and moderator density coefficients for mixed core apparently indicate lower safety margins for this core. However, detailed transient safety analysis of mixed core based on these results have proved that overall impact of all the above mentioned safety parameters for mixed fuel core do not differ significantly from that of LEU core. Therefore, PARR-1 can be operated safely with mixed fuel.

Keywords: PARR-1, LEU Fuel, Mixed Fuel, Safety Parameters, WIMS-D/4, CITATION, Nuclear Cross-sections Data.

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